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In re Application of:

Applicant : Aoi TANAKA et al.

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Title : FUEL CELL

DECLARATION UNDER 37 C.F.R. 1.132

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SIR:

I, Aoi MUTA, hereby declare as follows:

Date of preparation: July 9, 2008
Certifier: Aoi MUTA
Address: 4-23-302, Takatsuki-cho, Takatsuki-shi, 569-0803
Position: Chief engineer
Profile:
 March 2000: Graduated from Graduate School of Engineering,
 Osaka University
 April 2000: Joined Matsushita Electric Industrial Co., Ltd.
Experimental institution: Dia Analysis Service Co., Ltd.
Experimental period: June 10, 2008

The following experiments and information were both prepared and conducted under my supervision.

1. Object

•To calculate the maximum bondable number of silane compounds per unit area on the surface of a platinum-carrying carbon catalyst.

The amount of surface functional groups on a platinum-carrying carbon catalyst was quantified.

The density of surface functional groups per unit area was calculated from the amount of surface functional groups and the specific surface area of the catalyst.

A silane compound can be bonded to only the functional groups on the

platinum-carrying carbon catalyst.

2. Condition

- Measurement of the density of functional groups per unit area on the surface of a platinum-carrying carbon catalyst

The amount of surface functional groups on a platinum-carrying carbon catalyst is measured by pH titration.

From this result, the density of functional groups per unit area on the surface of the platinum-carrying carbon catalyst is calculated.

3. Result

- The amount of surface functional groups on a platinum-carrying carbon catalyst

Sample A: 0.48 meq/g

Sample B: 0.67 meq/g

- The specific surface area of the platinum-carrying carbon catalyst

Sample A: 800 m²/g

Sample B: 270 m²/g

- The density of functional groups per unit area on the surface of the platinum-carrying carbon catalyst

Sample A: $0.48 \times 6.0 \times 10^{23} \times 10^{-21} \div 800 = 0.36 \text{ nm}^{-2}$

Sample B: $0.67 \times 6.0 \times 10^{23} \times 10^{-21} \div 270 = 1.48 \text{ nm}^{-2}$

4. Consideration

From the above experimental results, the bonding density of a coupling agent per unit area on the surface of the platinum-carrying carbon catalyst is 1.48 nm⁻² at maximum.

Furthermore, the density of functional groups per unit area on a SiO² surface (cited from Table 1 of Langmuir 1987, 3, 316–318) is 4.9 nm⁻². (Samples A and B are not treated at a temperature of 300°C or higher; therefore, as the density of functional groups per unit area on the SiO² surface, the value at 180–200°C that is a lowest temperature range in Table 1 is used). Therefore, the density of a coupling agent per unit area on the SiO² surface is 4.9 nm⁻² at maximum.

Thus, the bonding density of a coupling agent per unit area on the SiO² surface is about 3.3 times the bonding density of a coupling agent per unit area on the platinum-carrying carbon catalyst.

Gyoten teaches that a silane compound is bonded to the surface of a catalyst


particle or a carrier of the catalyst particle. From the experimental results of the above Samples A and B, it can be considered that the density of a silane compound that can be bonded to the surface of the catalyst particle or the carrier of the catalyst particle is 1.48 nm^{-2} or less. If silica is added as described in Stonehart, it is apparent that the density of a silane compound contained in a catalyst layer is 1.48 nm^{-2} or less.

In contrast, according to claim 1 of the invention of the present application, a silane compound is first bonded to the surface of silica. It is thus considered that the silane compound in a density of about 4.9 nm^{-2} can be bonded to the surface of silica. After that, silica with the silane compound bonded to the surface thereof and catalyst particles are mixed. Therefore, when silica and the catalyst particles are mixed, the density of the silane compound contained in a catalyst layer can be increased. In other words, when silica and the catalyst particles are mixed at the same ratio, the density of a silane compound contained in the catalyst layer obtained from claim 1 of the invention of the present application can be increased, compared with that of a silane compound contained in the catalyst layer obtained from a combination of Gyoten and Stonehart.

Gyoten and Stonehart neither describe nor suggest the characteristic configuration of claim 1 of the present invention of the present application: "a silane compound is bonded to the surface of silica, and thereafter, the silica with the silane compound bonded to the surface thereof and catalyst particles are mixed". Accordingly, the configuration of claim 1 of the invention of the present application would not be obtained even by combining Gyoten with Stonehart.

I declare under the penalty of perjury of the laws of the United States of America that the foregoing is true and correct to the best of my knowledge and belief.

Signed this July 23, 2008, at Osaka, JAPAN


Aoi MUTA